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Vegetation Assessment of the South Pool of Chautauqua National Wildlife Refuge

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Introduction

Wetlands in Illinois, and principally the Illinois River valley, are significant migration areas for waterfowl in the Mississippi Flyway (Havera 1999). Aerial inventories of waterfowl conducted by the Illinois Natural History Survey (INHS) have indicated that Lake Chautauqua is one of the most important waterfowl refuges in the Illinois River valley with respect to use (Havera 1999). Currently, Chautauqua National Wildlife Refuge (CNWR) manages the Lake Chautauqua basin using a bisecting levee to promote moist-soil wetland conditions for dabbling ducks (i.e., south pool) and deep-water habitat for diving ducks and fish (i.e., north pool; Bowyer et al. 2005). In years when the south pool is managed to promote moist-soil vegetation, refuge personnel dewater the south pool in mid-summer to expose mudflats for migrating shorebirds and promote growth of moist-soil plants that produce seeds and tubers, important foods of waterfowl (Havera 1999). In years when CNWR produces abundant moist-soil vegetation, peak abundances of ducks have exceeded 375,000 during fall migration (INHS, unpublished data).

Despite significant investments in infrastructure and levees, managing CNWR to provide food resources for migratory waterfowl each fall and spring can be difficult due to spring and summer flooding of the Illinois River (Bellrose et al. 1983, Bowyer et al. 2005). Prior to extensive channelization, sedimentation, and floodplain drainage, the natural hydrology of the Illinois River resulted in low water during summer and early fall in floodplain lakes and wetlands, which exposed mudflats and allowed colonization by moist-soil plants. During fall, river levels typically increased and inundated the mudflats and associated vegetation, making the food resources produced during low water available to migrating waterfowl. When managed to produce moist-soil vegetation, refuge personnel attempt to mimic similar hydrology in the south pool. However, high summer water levels in the south pool from 2006–2011 prevented emergent plant development and food production for waterfowl. During years without the abundant moist-soil plants in the south pool, peak abundances have dropped below 32,000 ducks during fall migration (INHS, unpublished data).

Moreover, prolonged flooding of the south pool and major flood events have altered the typical wetland hydrology which may have affected plant communities. Influxes of sediments, nutrients, and fish into the south pool and prolonged (>5 years) flooding greatly reduced annual plant productivity and may have affected seed bank stocks. A large fish kill in summer 2012 during dewatering of the south pool increased notoriety of CNWR's moist-soil management techniques. The combination of public awareness of management practices and potential changes in the moist-soil plant community due to prolonged high river levels necessitate a quantification of the effects of the drawdown in 2012 (Strader and Stinson 2005).

Previous studies at CNWR (e.g., Bowyer et al. 2005) indicated that the species composition and seed production of moist-soil plant communities vary with drawdown dates and environmental conditions related to weather, rate of drawdown, and plant succession. Moist-soil plant establishment, species composition, and seed production in the south pool of CNWR were evaluated during the growing seasons of 1999–2001, and the area was cover mapped in 2002 and 2004. Cover mapping produced spatially-explicit maps and species compositional descriptions of vegetation communities. However since that time, high water has prevented moist-soil plant growth in most years and complete cover mapping and vegetation assessment have not been completed and compared with previous years.

Objectives

1) Produce a cover map of vegetation communities and other cover types within the south pool of CNWR during fall 2012
2) Predict duck energy days for vegetation communities within the south pool of CNWR using a published index of seed production and available energy values

Methods

We mapped vegetation communities in the south pool of CNWR in fall 2012 and inferred seed production and duck energy days (DED) using a seed production index and published energy values (Kaminski et al. 2003, Bowyer et al. 2005, Naylor et al. 2005). We established 24 transects along the southeast and northwest levees of the south pool and followed each, as possible, to the center ditch of the south pool (Bowyer et al. 2005). Along each transect, we noted the dominant plant taxa within each distinct vegetation community and conducted a visual assessment of the density and quality of the vegetation for waterfowl (i.e., seed production index [SPI]; Naylor et al. 2005, Stafford et al. 2011). We collected at least one SPI for each habitat occurring along each transect, with no fewer than 3 SPIs per transect.

In addition to describing quality of plant communities, we noted any changes in cover types observed along or between transects. Generally, distinct vegetation communities were determined by the tallest vegetation covering ≥30% of a given area of ≥0.5 ha. We delineated vegetation communities based on dominant plant species of greatest vertical height (Table 1). For example, an area dominated by Walter's millet (*Echinochloa walteri*) with an understory of redroot flatsedge (*Cyperus erythrorhizos*) was designated "annual grass-sedge." In instances where more than one plant community type was present and dominant (≥30% horizontal cover), both communities were noted, with the tallest or most dominant community listed first. For example, an overstory of tall willows (*Salix* spp.) with an understory of redroot flatsedge was classified as "bottomland forest / annual grass-sedge." We classified woody vegetation >3 m in height as bottomland forest and as scrub-shrub if 1–3-m tall. Woody vegetation <1 m in height was classified as perennial broadleaf.

We used a predictive equation to estimate seed and tuber production from SPI values for each vegetation community encountered along transects. We then averaged all SPI production values to estimate a mean predicted seed density for each dominant vegetation community. Because Stafford et al. (2011) found the SPI of Naylor et al. (2005) to be conservative when applied to moist-soil wetlands in Illinois, we increased production estimates using a standard correction factor (1.72) developed from seed production estimates and SPI values from Stafford et al. (2011). We calculated duck energy days (DEDs) using the mean energetic value of moist-soil seeds (2.5 kcal/gram; Kaminski et al. 2003), daily energy requirements of a mallard-sized duck (292 kcal/day; Reinecke et al. 1989), and mean production estimates from SPIs corrected for moist-soil wetlands in Illinois (Naylor et al. 2005, Stafford et al. 2011).

We digitized by hand all vegetation communities in ArcGIS 10.1 using field notes and waypoints of cover-type boundaries overlaid on high-resolution, color-infrared aerial imagery collected during fall 2012 by the United States Fish and Wildlife Service. We summarized the area of each dominant vegetation community and multiplied by the predicted DED value for each to estimate total DEDs in the south pool. Additionally, we estimated the total number of mallard-sized ducks that could potentially meet all of their energy requirements from the south pool during a 40-day fall stopover period.

Results

We identified 12 dominant cover types on the south pool in fall 2012, but 3 accounted for approximately 90% of the total area and DEDs (Table 1). We estimated seed and tuber production of 943.4 kg/ha (SE = 40.1, n = 108) across transects and cover types with 7,630,963 cumulative DEDs available in the south pool. Assuming an average 40-day stopover period, the south pool could support the energetic needs of up to 190,968 ducks during fall migration. The annual grass-sedge cover type accounted for approximately 53% of the available DEDs and represented 50% of the available cover. The annual broadleaf and annual grass-sedge cover type accounted for approximately 22% and 19% of total DEDs and overall cover, respectively; whereas bottomland forest with a grass-sedge understory accounted for 18% and 20% of total DEDs and overall cover, respectively.

Generally, vegetation response to the summer drawdown was extensive in the south pool and many areas had average to excellent seed production. Areas southeast of the center ditch were dominated by grass and sedge vegetation communities with a large percentage of vegetation comprised of Walter's millet, redroot flatsedge, and teal lovegrass (*Eragrostis hypnoides*; Table 2; Fig. 1, 2, 3). There was abundant and high-quality vegetation (e.g., common barnyardgrass [*Echinochloa crus-galli*], smartweeds [*Polygonum* spp.]) in the understory of the dead bottomland forest (i.e., primarily willows) on the southeast side of the ditch, but vegetation of more variable quality (e.g., morning-glory [*Ipomoea* spp.], pigweed [*Amaranthus* spp.], boneset [*Eupatorium* sp.]) northwest of the center ditch within the understory of the dead bottomland forest. Southern areas outside of the willows contained abundant grasses and sedges (e.g., chufa [*Cyperus esculentus*]) that are of high quality to ducks. The area immediately northwest of the center ditch was primarily composed of redroot flatsedge. Beyond the first zone of willows northwest of the center ditch, vegetation response was variable and represented more facultative species than along or southeast of the center ditch. This large open area between willow communities contained medium- to high-quality vegetation overall and was largely dominated by broadleaf plants (e.g., pigweed), but also contained some smaller zones dominated by vegetation that may be of low to moderate quality for waterfowl (e.g., morning-glory).

Discussion

The drawdown of the CNWR south pool in summer 2012 produced diverse and high-quality vegetation communities important to migrating waterfowl. The drought of summer 2012 likely allowed some areas of the south pool (e.g., north and northwest of center ditch) to dry completely and encouraged facultative and more xeric-adapted species to out-compete typical moist-soil species. However, most of the south pool contained desirable species of high quality for waterfowl. Interestingly, several areas produced dense and high-quality moist-soil vegetation in the understories of dead willows. Thus, standing dead willow did not prevent some areas from producing excellent moist-soil vegetation. However, the dead willows may prevent management (e.g., disking) or hinder function of water control structures and should be controlled in the future.

Additionally, we noted several large areas south and southeast of the center ditch where standing water persisted throughout summer and maintained some open water and emergent marsh habitats. If a goal of the refuge is to completely dewater the entire area southeast of the center ditch, additional notches or breaks in the center ditch spoil pile should be created. Retaining some water southeast of the center ditch likely increases the diversity of wetland plants present in the south pool and may provide habitat for additional wildlife species during drawdown; however, mechanical moist-soil management capabilities in that area will be reduced if conditions prevent complete dewatering (Fredrickson and Taylor 1982).

Moist-soil seed production on the south pool of CNWR was greater than estimates from wetlands managed by the Illinois Department of Natural Resources (691 kg/ha; Stafford et al. 2011), public moist-soil wetlands in the Mississippi Alluvial Valley (556 kg/ha; Kross et al. 2008), and previous estimates on the south pool (790 kg/ha; Bowyer et al. 2005). Mean predicted seed production was slightly less than measured on Emiquon Preserve in fall 2011 (1,116 kg/ha), but this seed density was only encountered on a small proportion of the Preserve. Interestingly, our estimates of moist-soil seed production in dead willows were much greater than previous estimates completed when the willows were living (Bowyer et al. 2005). Overall, our estimate of DEDs was approximately 20% greater than estimates of Bowyer et al. (2005), but was within the range encountered during their study years.

Although the drought in late summer and early fall 2012 likely prevented some mesic-adapted species (e.g., smartweed) from growing in dryer areas of the south pool (e.g., north and northwest of the center ditch between the willow communities), most of the south pool contained high-quality vegetation. Understories of the dead willows on the southeast side of the center ditch produced abundant herbaceous vegetation and likely benefitted the most from the willow control program undertaken by CNWR. Given the vegetation response in summer 2012, prolonged flooding and other willow management activities apparently improved the moist-soil vegetation in more than 20% of the south pool where willows persisted. Prolonged flooding apparently did not negatively impact the moist-soil vegetation community relating to carrying capacity for ducks. We suggest continuing control of willows in the south pool as needed to maximize moist-soil vegetation for ducks and other waterfowl.

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Table 1. The total area (acres [Ac] and hectares [Ha]), mean seed production index value (SPI), mean estimated seed and tuber production value per hectare using the SPI from Naylor et al. (2005; P_o; kg/ha) and the SPI corrected for moist-soil wetlands in Illinois (P_c; Stafford et al. 2011), estimate of duck energy days per hectare (DED), and the total DEDs for each dominant vegetation community or other horizontal cover (Cover Type) in the south pool of Chautauqua National Wildlife Refuge, Illinois during fall 2012.

Cover Type	Ac	Ha	SPI	P_o	P_c	DED	Total DED
Annual grass-sedge	1,163.7	470.9	40.8	579.5	999.7	8,559	4,030,477
Annual grass-sedge / annual broadleaf	67.3	27.2	37.7	521.8	900.2	7,707	209,625
Perennial grass-sedge	6.6	2.7	17.3	132.8	229.1	1,961	5,296
Annual broadleaf	13.0	5.3	44.8	657.2	1,133.6	9,706	51,439
Annual broadleaf / annual grass-sedge	444.9	180.0	43.6	633.2	1,092.2	9,351	1,683,221
Bottomland forest	18.6	7.5	17.6	190.9	329.3	2,819	21,144
Bottomland forest / annual grass-sedge	454.8	184.0	36.6	501.5	865.2	7,407	1,363,234
Bottomland forest / annual broadleaf	67.7	27.4	43.2	626.7	1,081.1	9,256	253,760
Scrub-shrub	4.9	2.0	33.0	432.2	745.6	6,383	12,766
Mudflat	10.8	4.4	-	0.0	0.0	0.0	0.0
Bare soil	17.6	7.1	-	0.0	0.0	0.0	0.0
Open water	43.7	17.7	-	0.0	0.0	0.0	0.0
Total	**2,313.6**	**936.3**					**7,630,963**
Total Stopover Ducks [a]							190,774

[a] The estimated number of mallard-sized ducks that could potentially meet all energy requirements within the south pool of CNWR for a stopover period of 40 days.

Table 2. Examples of species encountered within each vegetation community representing overall frequency of occurrence.

Vegetation Community	Description
Annual grass-sedge	Composed primarily of nonpersistent grasses and sedges with common species including: *Cyperus erythrorhizos, Echinochloa crus-galli, E. walteri, Eragrostis hypnoides, Leersia oryzoides, Leptochloa* spp., *Panicum* spp.
Annual grass-sedge / annual broadleaf	Composed primarily of nonpersistent grasses and sedges and some broadleaf plants with common species including: *Amaranthus* spp., *Cyperus erythrorhizos, C. esculentus, Echinochloa crus-galli, E. walteri, Eragrostis hypnoides, Ipomoea* spp., *Panicum* spp., *Polygonum lapathifolium, P. pensylvanicum*
Perennial grass-sedge	Composed primarily of persistent perennial grasses and sedges and interspersed annual nonpersistent grasses, sedges, broadleaf plants and dead willows with common species including: *Bidens cernua, Cyperus erythrorhizos, Echinochloa crus-galli, E. walteri, Leersia oryzoides, Salix nigra, Schoenoplectus fluviatilis*
Annual broadleaf	Composed primarily of nonpersistent broadleaf plants with common species including: *Abutilon theophrasti, Amaranthus* spp., *Ammania spp., Bidens cernua, Cyperus erythrorhizos, Eleocharis* spp., *Eragrostis hypnoides, Ipomoea* spp., *Panicum* spp., *Phyla lanceolata, Polygonum lapathifolium, Salix nigra*
Annual broadleaf / annual grass-sedge	Composed primarily of nonpersistent broadleaf plants and some nonpersistent grasses and sedges with common species including: *Abutilon theophrasti, Amaranthus* spp., *Cyperus erythrorhizos, C. odoratus, Echinochloa walteri, Eragrostis hypnoides, Ipomoea* spp., *Panicum* spp., *Phyla lanceolata, Polygonum lapathifolium*
Bottomland forest	Composed primarily of living trees and few plants in the understory with common species including: *Acer saccharinum, Aster* sp., *Cephalanthus occidentalis, Conyza canadensis, Cyperus erythrorhyzos, Echinochloa crus-galli, Eragrostis hypnoides, Eupatorium* sp., *Leersia oryzoides, Leptochloa* spp., *Panicum* spp., *Salix nigra, Schoenoplectus fluviatilis*
Bottomland forest / annual grass-sedge	Composed primarily of dead trees and abundant nonpersistent grasses and sedges in the understory with common species including: *Amaranthus* spp., *Cyperus erythrorhizos, Echinochloa crus-galli, E. walteri, Eragrostis hypnoides, Ipomoea* spp., *Leptochloa* spp., *Panicum* spp., *Polygonum lapathifolium, P. pensylvanicum, Salix nigra*

Table 2. Continued.

Bottomland forest / annual broadleaf	Composed primarily of dead trees and abundant nonpersistent and some persistent broadleaf plants in the understory with common species including: *Abutilon theophrasti, Amaranthus* spp.*, Ammania* spp., *Bidens cernua, Cyperus erythrorhizos, Eragrostis hypnoides, Ipomoea* spp., *Panicum* spp.*, Phyla lanceolata, Polygonum lapathifolium, P. pensylvanicum, Salix nigra, Sicyos angulatus*
Scrub-shrub	Composed primarily of small dead trees and buttonbush with few or no plants in the understory with common species including: *Cephalanthus occidentalis*
Mudflat	Moist or saturated, exposed soil with <30% vegetation cover
Bare soil	Dry exposed soil with <30% vegetation cover
Open water	Surface water with <30% emergent vegetation cover

Figure 1. Cover types (solid) on the south pool of Chautauqua National Wildlife Refuge (CNWR) during fall 2012 with color imagery from summer 2010.

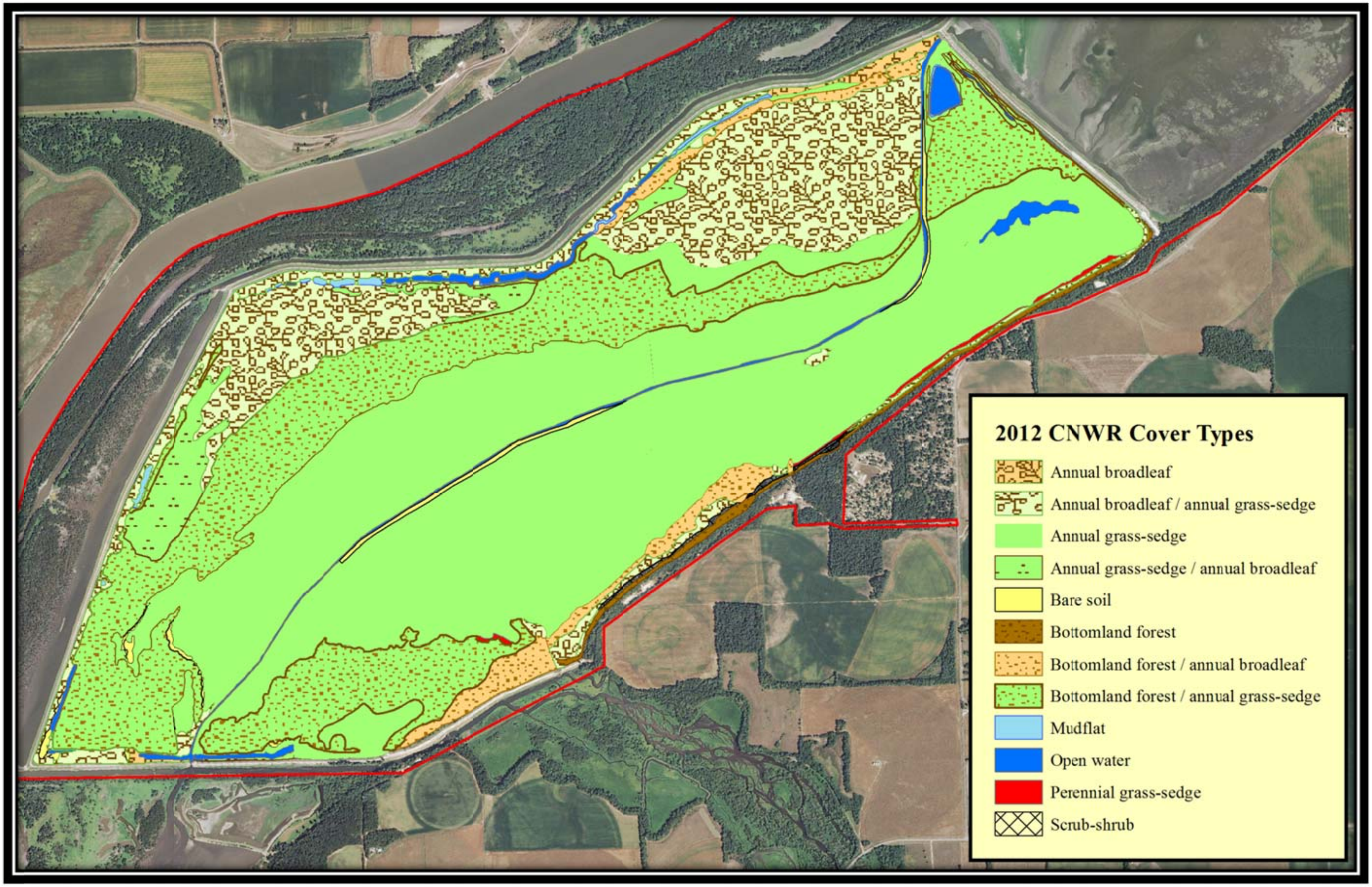


Figure 2. Cover types (semi-transparent) on the south pool of Chautauqua National Wildlife Refuge (CNWR) during fall 2012 with color-infrared imagery from summer 2012.

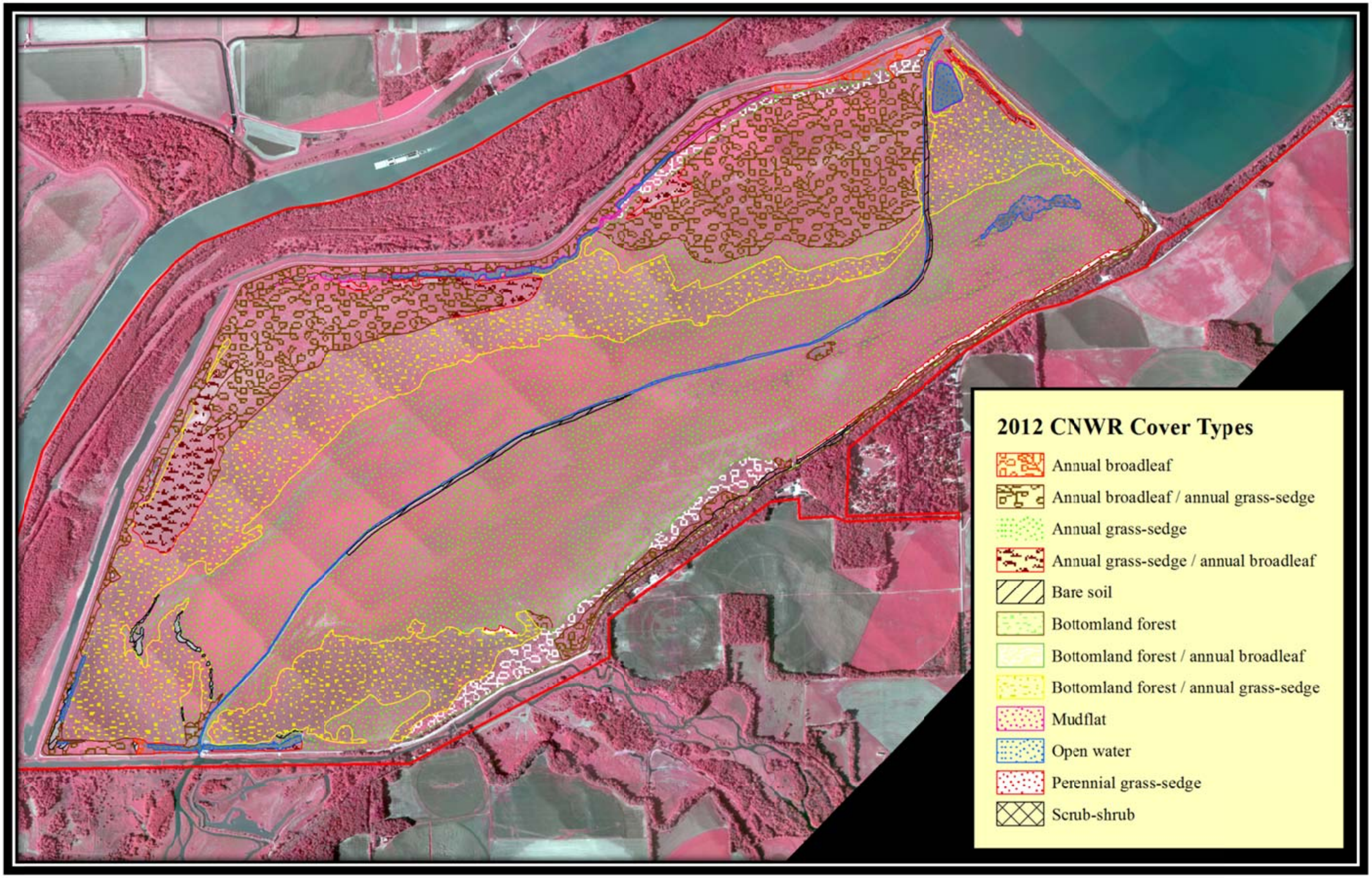
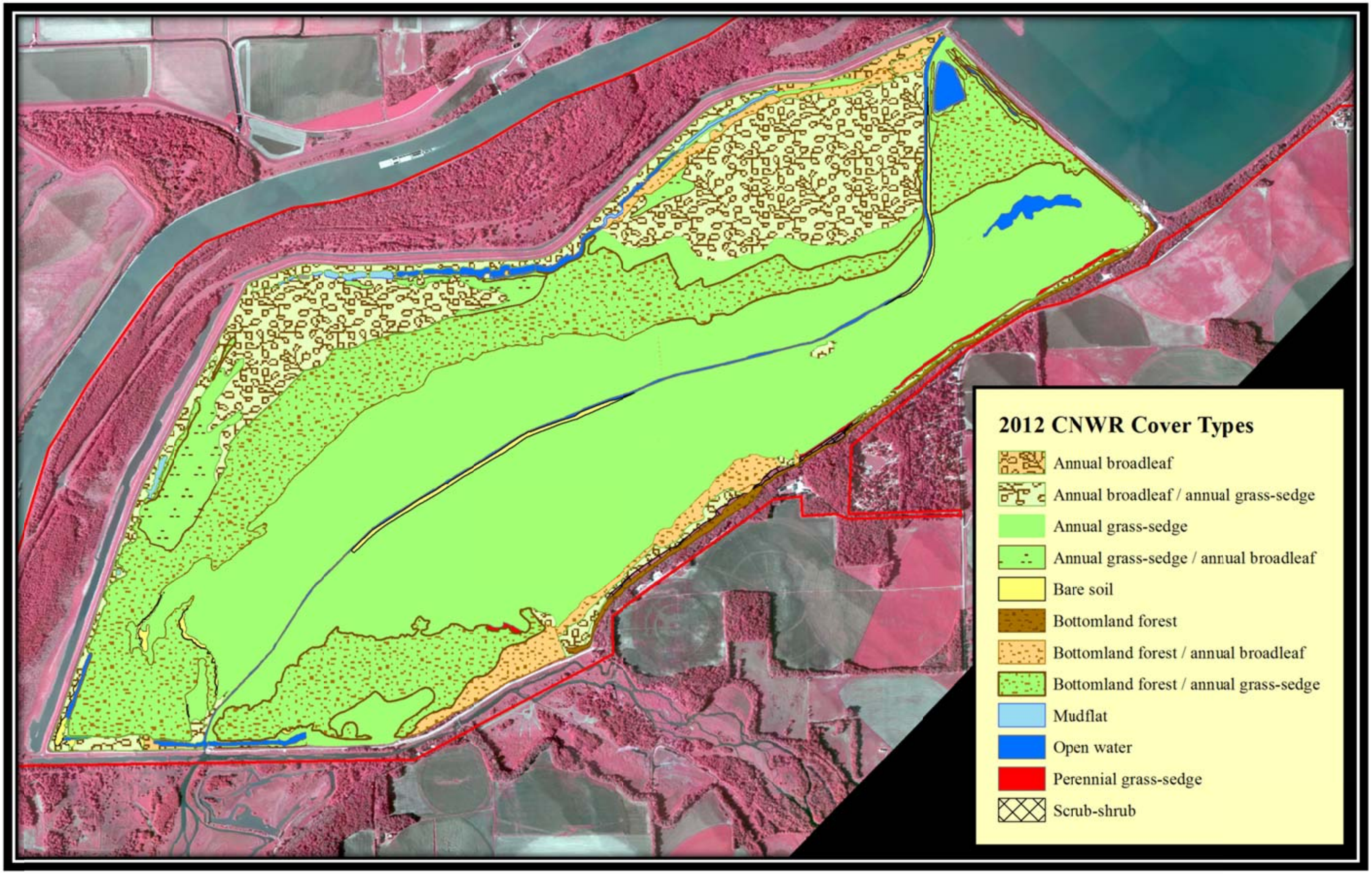


Figure 3. Cover types (solid) on the south pool of Chautauqua National Wildlife Refuge (CNWR) during fall 2012 with color-infrared imagery from summer 2012.



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